OBITUARY NOTICES OF FELLOWS DECEASED.

Jean Victor Poncelet, Foreign Member of the Royal Society, was born at Metz on the 1st of July, 1788. After having studied Mathematics for two years at the Lycée Imperial of Metz, he was admitted to the École Polytechnique, where he remained till 1810, his studies in the meanwhile having been interrupted by a serious illness. He then entered the École d'Application of Metz as Sublieutenant of Engineers, and left it in March 1812, in order to assist in constructing the defensive works of Ramekens in the island of Walcheren. His first engineering work here was the erection of a casemated fort in a very limited time, on a peat soil, without having at his command proper materials for a foundation. In the month of June 1812 he was called away to take part in the Russian campaign, and joined the invading army at Vitepsk. On the 18th of August he reconnoitred Smolensk, exposed to the fire of the garrison, and afterwards took an active share in the battle fought the same day. On the 19th he was employed in throwing bridges over the Dnieper below Smolensko, under the fire of the Russian batteries on the opposite bank of the river. Deceiving the enemy by an ostentatious display of preparations for crossing at a particular spot, he succeeded in constructing bridges at other points better protected from the Russian fire. During the retreat from Moscow, at Krasnoi, not far from Smolensko, seven thousand French soldiers under the command of Ney, without artillery, encountered twenty-five thousand Russians with forty-five pieces of artillery, under Prince Miloradowich, on the 18th of November, 1812. In this battle Poncelet charged the Russian batteries at the head of a column of sappers and miners; his horse was killed under him, and he was taken prisoner. After a painful four months' march through snow, half naked and ill fed, in a season when mercury was repeatedly frozen, he arrived at Saratoff on the Volga. In April 1813, on recovering from an illness brought on by the hardships he had endured, he resolved to occupy his unwelcome leisure with the study of descriptive geometry. But his recollections of the teaching of Monge, Carnot, and Brianchon had been totally effaced by the privations and sufferings he had undergone. Without books to aid him he was obliged, with much labour, to construct bit by bit the elementary propositions required for the line of research he was desirous of following. The results of his labours at this time were afterwards published in Gergonne's 'Annales,' from 1817 to 1821; and the original manuscripts, written at Saratoff, were published in 1862. On the conclusion of peace in June 1814, he quitted Saratoff for France, where he arrived in September of the same year. From 1815 to 1825, as Captain of Engineers, he superintended the construction of machinery in the arsenal of Metz. From 1825 to 1835 he was Professor of Mechanics; and while he imparted to the young officers clear ideas of mechanical science, capable of immediate practical application, he delivered, at the suggestion of Baron Dupin, gratuitous evening

lectures on geometry to the artisans of the place, and thereby contributed largely to the establishment of those courses of public lectures that have brought the most fertile results of scientific research within the grasp of the whole nation. In addition to these labours he wrote his 'Traité des Propriétés Projectives des Figures' (1822), 'Cours de Mécanique appliqué aux Machines' (1826), and many memoirs on Geometry and Applied Mechanics in Gergonne's and Crelle's journals. He also invented a drawbridge with a variable counterpoise, and an undershot water-wheel with curved buckets, now known throughout Europe by the name of Poncelet's wheel, which nearly doubles the useful effect of a given water-power. He was promoted to the rank of Chef de Bataillon in 1831, and became a Member of the Institute in 1834. From 1835 to 1848 he was on the Committee for constructing the Fortifications of Paris, and was successively appointed Professor of Mechanics at the Sorbonne and at the Collége de France; became Lieutenant-Colonel in 1841, Colonel in 1844, and General of Brigade on the 19th of April, 1848. A few days later he was appointed Governor of the École Polytechnique, a post which he held till 1850. During the troubles of June 1848, placing himself at the head of the pupils of the École Polytechnique, he led them through the barricades to the Luxembourg, where they formed a guard of honour for the protection of the Provisional Government. For this important service General Cavaignac appointed him to the command of the National Guards of the Department of the Seine. He was also elected a Member of the Constituent Assembly. As President of the Scientific Commission sent to the English Exhibition of 1851, he drew up a Report on the progress of the Arts involving the application of Science during the last half century. Besides the works already mentioned, he wrote a large number of Memoirs and Scientific Reports in the Mémorial du Génie, les Avis du Comité des Fortifications, and the Comptes Rendus. He was Grand Officier of the Legion of Honour, Chevalier of the Prussian Order "Pour le Mérite," Corresponding Member of the Academies of Berlin, St. Petersburg, Turin, and of many other learned Societies; his election as Foreign Member of the Royal Society took place in 1842. After a long and painful illness, he died in Paris on the 23rd of December, 1867.

Nathaniel Bagshaw Ward, F.R.S., F.L.S., who died on June 4th 1868 in his 77th year, was a sonnd practical botanist, and was especially known as the inventor of the closely glazed cases for the growth of plants, which bear his name. When quite young he evinced a taste for natural history and made his little collections of plants and animals. A voyage to Jamaica when he was thirteen years old, and the contemplation of the luxuriant vegetable life of that island, inspired him with an ardent love for the science of botany. He was educated to the medical profession, and for many years of his life was engaged in its practice in the east end of London. His leisure time, however, was devoted to the study and culti-

vation of plants; and his house in Wellclose Square was conspicuous for the vegetation which surrounded it. But the deleterious atmospheric influences to which it was exposed subjected him to continual vexation and disappointment; and the only way in which he could maintain a fluctuating appearance of freshness and verdure was by bringing back a renewed supply of plants on the occasion of any visit to nursery grounds or the country. In the summer of 1829, a solution of his difficulties presented itself. He had placed the chrysalis of a moth in some mould in a glass bottle covered with a lid, in order to obtain a perfect specimen of the insect; after a time a speck or two of vegetation appeared on the surface of the mould, and turned out to be a fern and a grass. His interest was excited; he placed the bottle in a favourable situation and found that the plants continued to grow and to maintain a healthy appearance. On reflecting upon the matter, he found that the conditions necessary to the life of the plants were maintained, and deleterious agents, as soot, noxious gases, drying winds, &c., were excluded. The first Wardian case gave rise to numerous others; and in two or three years the success of the plan was satisfactorily demonstrated. In 1836 Mr. Ward wrote upon the subject to the late Sir W. Hooker; and the letter was published in the Companion to the Botanical Magazine for May of that year. In 1838 Mr. Faraday lectured upon the "cases" at the Royal Institution; and subsequently Mr. Ward himself explained his plan at various Societies and at Meetings of the British Association. In 1842 the first edition of Mr. Ward's work on "The Growth of Plants in Closely-glazed Cases" was published; and a second edition appeared a few years later.

It was soon recognized that Mr. Ward's method was susceptible of various valuable applications, of which the following may be noticed:—1. The growth of plants in the dwellings of all classes, in town as well as country. 2. The transport of plants to and from different countries: the tea-plant and the cinchona-tree have by means of the Wardian cases become established in India. 3. For purposes of philosophical investigation. 4. To the study and conservation of animals: the Vivaria were first established as a modification of the cases by Mr. Ward himself.

When residing at Wellclose Square, Mr. Ward gave frequent microscopical soirées. Out of these sprang the Microscopical Society in 1840, Dr. Bowerbank and the late Messrs. Quekett and Jackson having also taken part in its foundation. He was elected a Fellow of the Royal Society in 1852. In 1856, a large number of friends combined to recognize Mr. Ward's services by having his portrait painted by J. P. Knight, R.A., and placed in the meeting-room of the Linnean Society.

The estimation in which the subject of this notice and his scientific services were held by those best capable of forming an opinion, will be shown by the following extracts from a letter written by Dr. Hooker to the editors of a scientific journal:—

"During the whole period that I knew Mr. Ward, and, I believe, for

many years before, his hospitable house, first in Wellclose Square, and afterwards at Clapham Rise, was the most frequented metropolitan resort of naturalists from all quarters of the globe of any since Sir Joseph Banks's day. His unpretending entertainments were frequent, for many years periodic, and often weekly. On these occasions his many scientific friends flocked to see himself, his live plants, and the many specimens, instruments, and preparations he had collected to instruct and entertain them; and on such occasions it was that many a country and colonial naturalist was introduced for the first, and too often for the last time in his life, to some of the most eminent naturalists in Europe.

"Of the value of that contrivance which justly bears his name, the Ward's case, it is impossible to speak too strongly; and I feel safe in saying that without its aid a large proportion of the most valuable economic and other tropical plants, now cultivated in England, would not yet have been introduced." "Of even more consequence was the application of these cases to town gardening, whereby he has afforded to the denizens of this metropolis far greater and purer pleasures than all artists, house-decorators, &c. have contributed; for a primrose placed in flower under a bell-glass at Christmas in a London drawing-room will charm when a Raphael does not, and will charm none the less when a Raphael charms also." "In the memory of all who knew him, Mr. Ward will live as a type of a genial, upright, and most amiable man, an accomplished practitioner, and an enthuiastic lover of nature in all its aspects."

Mr. Robert Porrett was born on the 22nd September 1783. His father held the office of Ordnance Storekeeper in the Tower, and resided there; and the son, having early shown an aptitude for such a situation, was employed as his father's assistant, and, succeeding him in his appointment, eventually rose to be chief of the department. His official work, not being of an engrossing nature, left him leisure to apply his intelligent and inquiring mind to scientific pursuits, especially to chemistry; and inasmuch as he received a medal from the Society of Arts for a chemical discovery in 1809, he was probably at the time of his death the oldest representative of experimental chemistry in this country. In fact he was a worker in chemistry before the introduction of the atomic theory, and was among the first to apply the new doctrine to the verification of chemical analysis. Mr. Porrett's earliest researches were on hydro-ferrocyanic and hydro-sulphocyanic acids, of which he was the discoverer. The investigation of the constitution of these acids (which he named *ferruretted* and *sulphuretted chyazic acids*) and of their salts forms the subject of various papers which he contributed between 1809 and 1819 to the 'Philosophical Transactions' and other scientific publications: they are as follows:—"On Prussic and Prussous Acid," Trans. of the Soc. of Arts, vol. xxvii. 1809, p. 89; "On the Nature of the Salts termed triple Prussiates," &c., Phil. Trans. 1814, p. 527; "Further Analytical Experiments relative to the Constitution

of the Prussic, of the Ferruretted Chyazic, and of the Sulphuretted Chyazic Acids, and on that of their Salts; together with the application of the Atomic theory to the analysis of these Bodies," Phil. Trans., 1815, p. 220; "On the Anthrazothion of Von Grotthus, and on Sulphuretted Chyazic Acid," Thomson's Annals of Philosophy, vol. xiii. (1819) p. 356; "On the Triple Prussiate of Potash," Ann. Phil. vol. xii. p. 214, which contains a discussion of his own analyses of "ferruretted chyazic acid," and that of Dr. Thomson, published in a previous part of the same volume; "On Ferrochyazate of Potash, and on the Atomic weight of Iron," Ann. Phil. vol. xiv. 1820, p. 205.

In 1813 Mr. Porrett was engaged with Messrs. Wilson and Rupert Kirk in an investigation of chloride of nitrogen, with a view chiefly to the examination of the physical properties and chemical composition of that dangerously explosive compound, and the discovery of safe and suitable processes for preparing it.

In 1816 he communicated to Thomson's Annals of Philosophy, vol. viii. p. 74, an account of "Two Curious Galvanic Experiments," in which he showed that a fluid is made to pass against gravity by the electric current through a membrane from the positive to the negative pole when the conducting wires of a battery are connected with water placed at different levels on each side of the membrane. The fact so discovered by him is by German writers generally associated with his name as "das Porrettsche Phänomen." He also described the increase of action which is produced in an exhausted voltaic battery by removing a portion of the fluid, whereby the still moist plates are exposed to the action of the air. In 1817 he made some "Observations on the Flame of a Candle," which were published in the 'Annals of Philosophy,' vol. ix. p. 337.

After an interval of twenty-six years, he again, in 1846, at the age of sixty-three, took up chemical investigation, and contributed, in conjunction with the late E. F. Teschemacher, a paper "On the Chemical Composition of Gun Cotton" (Memoirs of the Chemical Society, vol viii. 1845–1848, p. 258). His last paper "On the existence of a new Vegeto-Alkali in Gun Cotton," for which he proposed the name of Lignia, was read before the Chemical Society on December 21st of the same year, and is printed in the Memoirs, vol. iii. p. 287.

While devoting his leisure time principally to chemistry, Mr. Porrett also occupied himself with antiquarian pursuits, especially the study of ancient arms and armour, for which his residence in the Tower afforded favourable opportunity. He retired from official duty in 1850, after a service of 55 years. On that occasion his long and useful service was honourably recognized by his superiors, and he received most gratifying expressions of regard and attachment from his subordinate officers. He was a Fellow of the Astronomical and Antiquarian Societies, and one of the original members of the Chemical Society; his election into the Royal Society was in 1848. He died on the 25th November 1868, at the age of 85.

Carl Friedrich Philipp von Martius, Foreign Member of the Royal Society, was born on the 17th of April, 1794, at Erlangen, where his father, Ernst Wilhelm Martius, was Court Apothecary, and Honorary Professor of Pharmacy in the University. The family is said to have come from Italy, but had for several generations been settled in Germany. After a careful and judicious training at home, for which he was indebted chiefly to an intelligent and accomplished mother, young Martius received his general education in the school and the gymnasium of his native town. From his father he had inherited a taste for Natural History; and under the tuition of Professors Richter and Besenbeck, of the Gymnasium, he acquired a well-grounded knowledge of classical literature; so that a good foundation was laid for that well-balanced general mental culture of which the fruits are conspicuous in his writings. When not quite sixteen years of age, he entered the University of Erlangen. His main object was the study of medicine, but he also followed his early bent towards Natural History, and especially Botany. The Botanical Professor of that day was Schreber, who had himself studied under Linnæus; but Martius's attachment to the science was greatly fostered and promoted by the friendship of the brothers Nees von Esenbeck, then his fellow students, who afterwards rose to eminence as botanists. From the elder of the brothers Martius also received a tincture of the then prevalent "Natur-Philosophie," which may be perceived to colour his earlier writings; but its influence seems to have been but transient.

In March 1814 he was promoted with distinction to the degree of Doctor of Medicine, and published his inaugural dissertation under the title "Plantarum Horti Academici Erlangensis Enumeratio," a critical catalogue of plants arranged according to the Linnean system.

An event had happened some time before which decided Martius's future career. The Academy of Sciences of Munich, on the death of Schreber, sent to Erlangen two of its members, Schrank and Spix, to acquire his botanical collections for the Academy; and these naturalists, having seen the promise of future excellence evinced by the young man, invited Martius to apply for admission into the "Institution of Elèves," then existing in the Academy, in which the pupils had the advantage of following out the higher study of selected branches of science under the auspices of the Academy and the immediate guidance of certain of its members. Through the prospect thus set before him, the wish which Martius had already entertained of devoting himself entirely to botany, became a settled resolution. After going through the prescribed trials, he was in May 1814 received among the Elèves of the Academy, and appointed, under the direction of Schrank, now advanced in years, to be assistant in the management of the Botanic Garden at Munich, with an annual salary of 500 florins. Two years later he was advanced to the rank of "Adjunct of the Academy," an order which no longer exists, having been abolished, together with the Institute of Elèves, by King Louis in 1827.

Martius not only laboured zealously in the superintendence of the Garden, but made frequent excursions through Bavaria and the adjacent regions for the study of the indigenous flora; and it was on one of these occasions that he made the friendship of Hoppe, the Director of the Botanic Garden of Ratisbon, and began with him a scientific correspondence which was long-enduring. At this time he published the 'Flora Cryptogamica Erlangensis' (Norimbergi, 1817), which contained the results of his first independent researches, and met with high approval from his fellow workers in the science. His earnest devotion to study, his conspicuous talents, and his untiring activity, could scarcely fail to earn for him the regard of his older academical colleagues, such as Schrank, Schlichtigroll, Sœmmerring, and the Conservator General von Moll—all of them men fitted to produce a beneficial influence on his mental development. In like manner he attracted the kindly notice and favourable consideration of the King Maximilian Joseph I., who, being a great lover of plants, paid frequent visits to the Garden under the welcome guidance of the young superintendent; and this had an important effect on his future fortune.

This enlightened prince had for some time entertained the project of sending a scientific expedition to America; and as the Emperor of Austria was about to send out scientific explorers to Brazil in the retinue of the Archduchess Leopoldina, who was about to sail for that country as the bride of the Crown Prince of Portugal, afterwards the Emperor Don Pedro I. of Brazil, King Max. Joseph availed himself of the opportunity offered to him of sending out two Bavarian naturalists on that occasion. The choice fell on Spix as Zoologist, and Martius as Botanist, who was selected by the king himself. After but a brief time allowed for equipment, the two travellers sailed from Trieste on the 2nd of April, 1817, with the imperial cortége, and, after touching at Malta, Gibraltar, and Madeira, arrived at Rio Janeiro on the 15th of July. There they parted from the Austrian savans, and set out on their own journey.

It is unnecessary here to trace the course of their travels; suffice it to say that, after traversing the vast territory of Brazil in various directions, and ascending the River Amazons and its tributary the Hyapurá as far as the confines of Peru and New Granada, they arrived at Pará on their return journey on the 16th of April, 1820, three years after they had sailed from Europe. From Pará they were conveyed to Lisbon in a Portuguese ship of war, and reached Munich on the 8th of December, 1820.

This expedition, irrespective of the sea voyage, extended over nearly 1400 geographical miles, and for months led through the most inhospitable and dangerous regions of the New World. Both explorers, however, escaped without any important disaster on the road, and they had the rare good fortune to preserve and bring home their collections complete and uninjured.

The material fruits of the expedition consisted of about 6500 species of plants, the majority dried; but several living species, as well as seeds, were

also brought home. The zoological collections (to which Martius contributed also on his solitary voyage up the Hyapurá) numbered 85 species of Mammals, 130 of Amphibia, 350 of Birds, 116 of Fishes, 2700 of Insects, 80 of Arachnoids, and 80 of Crustacea. The species, especially the plants, are represented, many by numerous, and all by well-preserved specimens.

On their return home, the king nominated the travellers Knights of the Order for Civil Merit; and Martius received the appointment of ordinary member of the Academy of Sciences, and second conservator of the Botanic Garden.

In consequence of this expedition, the direction of Martius's future scientific activity was decided. Brazil was thenceforward the country to which he devoted the greater part of it. Before everything else his energy was centred on the flora of Brazil.

The first work made public relative to the Brazilian expedition was the Narrative of the Journey. It appeared in 1823–31, in three quarto volumes, accompanied by an atlas. The compilation of this work was originally intrusted conjointly to both travellers by Maximilian Joseph I.; but Spix did not long survive the completion of the first volume, and so it happened that by far the greater portion of the work proceeded from Martius's unaided pen. Of course in the 'Narrative of Travels' natural products are treated of more or less in detail; but it could not be occupied with the special discussion and elaboration of scientific matter. This was reserved for a separate work, which appeared contemporaneously in a magnificent series of volumes. In the first place Martius undertook only the botanical section, and Spix the zoological; but, on account of the death of the latter in 1826, when he had only worked up the mammals, the birds, and a part of the amphibia, the continuation of this part of the work also fell upon Martius. He acquitted himself of the task in the most satisfactory manner, having secured the assistance of Agassiz, Andreas Wagner, and Pertz, for the actual work, whilst he acted as editor. The publication of the botanical treasures took the form of a selection of the most interesting novelties. The Phanerogamia, or flowering plants, were illustrated in the 'Nova Genera et Species Plantarum Brasiliensium' (3 vols. fol., Munich, 1823–32), and the Cryptogamia in the 'Icones Selectæ Plantarum Cryptogamicarum Brasiliensium,' 1 vol., 1827). The first volume of the former work was prepared by Martius's colleague, Zuccarini, the remainder entirely by Martius, except the chapter in the 'Icones Selectæ' on the internal structure of Tree-Fern stems, from the pen of Hugo von Mohl—a chapter that served to enhance the value of the work in the highest degree. In these publications not only were many new and highly remarkable plants made known (more than 400 species and more than 70 genera), but they were also so fully and lucidly described that botany received an essential enrichment. A practised and quick sight for natural affinities, a happy gift of combination—in short, an essentially "systematic tact," placed Martius in the rank of the first botanists of his time.

A third work was taken in hand by Martius in 1823, and, indeed, the one with which his name will be most closely and enduringly connected. This was the Monograph of Palms, 'Historia Naturalis Palmarum' (3 vols. imp. fol., Munich, 1823–50). The peculiar richness of Brazil in Palms, the beauty of Brazilian forms, and the honour likely to accrue from a new and comprehensive work on this group of plants induced Martius to concentrate his attention upon them immediately after his arrival in Brazil. The fulfilment of this great undertaking cost twenty-eight years of labour and research.

For the matters with which he was less conversant, Martius obtained the cooperation of distinguished colleagues. The chapter on the anatomy of palms was written by H. von Mohl; the fossil palms fell to the share of F. Unger; and Sendtner and A. Braun contributed to the morphology. But by far the greater part came from the pen of Martius himself, notably:—the chapter on the geographical distribution of palms, in which Martius enunciated his views on phyto-geography in general; and the whole of the third volume, containing descriptions of all known palms, systematically arranged, and forming in itself an almost complete monograph of the family. The scientific merit of this work was universally acknowledged. Not only was the special knowledge of palms thereby greatly extended, but the science of botany in general was signally promoted; and it may be said, in the words of a great naturalist, that, "so long as palms are known and palms are grown, the name of Martius will not be forgotten."

The last great work by Martius to which we can refer on this occasion is the 'Flora Brasiliensis.' He had made an attempt, in conjunction with Nees von Esenbeck, to publish such a work on a small scale, but soon abandoned the idea; but in 1839, encouraged by Prince Metternich, he planned a far more ambitious publication, in conjunction with the celebrated Viennese botanist Endlicher. The groundwork of it was to consist of an entirely new and scientific elaboration of all the accessible materials brought together from Brazil, accompanied by numerous plates, thus forming a splendid systematic whole. To comprehend in some degree the magnitude of such an undertaking, it must be remembered that the flora of Brazil numbers almost five times as many species as that of the entire area of Central Europe. It was plain that the carrying out such a work could be accomplished only by the joint labours of many scientific men; and Martius was fortunate enough to obtain the services of the most eminent German and foreign botanists for this purpose. The Emperor Ferdinand I. of Austria, and the Emperor Don Pedro II. of Brazil, and also King Louis of Bavaria took the work under their special patronage. After Endlicher's death in 1849, Fenzl, his successor in office, supplied his place, as co-editor with Martius. At first the work proceeded slowly, on account of the novelty and costliness of the undertaking; but since the year 1850, in consequence of the increased interest taken in it by the Bra-

zilian Government, it has gone on more rapidly, and has now reached the 46th part. The completion, which Martius so longed to see, has been intrusted to his friend Dr. Eichler. It was one of Martius's last cares to take the needful steps to ensure its continuance; so that we may reasonably hope to see this noble monument of German industry in science brought to a close. Even now the parts that have appeared form the most comprehensive work in botanical literature yet published. Nearly 10,000 species are described, and these are illustrated by more than 1100 folio plates. It is evident that the editing and publication alone of so enormous a mass of matter is a performance worthy of the highest acknowledgment; but Martius's merit was by no means limited to that. True, of all the monographs published, two only were by Martius; but then he supplemented nearly all the others by valuable explanations on the geographical distribution and the medicinal, technical, and economical importance of the several plants. He also contributed a series of characteristic plates representing the vegetation ('Tabulæ Physiognomicæ'), accompanied by masterly definitions, in elegant Latin. He also contributed maps of the floral districts, routes of travel, &c. Several of the monographs in the 'Flora Brasiliensis' are esteemed as masterpieces; for in many cases the men who wrote them had previously devoted years of study to the respective groups. The mere enumeration of Martius's other writings would fill a long space, for there are more than 150 separate works. Among these may be specially mentioned his 'Beiträge zur Ethnographie und Sprachkunde Braziliens' as evidence, besides what appears in the narrative of his travels, that he devoted himself to other objects in Brazil besides the study of its natural history.

Reverting to the main facts of Martius's life, we left him in 1820, just after his return from Brazil, when he was nominated ordinary member of the Academy, and second conservator of the Botanic Garden. For some years his position remained unchanged. When, however, in 1826, King Ludwig I. ascended the throne, and the University of Landshut was removed to Munich, he was appointed Professor of Botany in that institution; and six years later, upon the retirement of the aged Schrank, he received the post of first conservator. With the exception of occasional journeys to England, France, Holland, &c., he discharged almost uninterruptedly the duties of both appointments until 1854. In 1840 he was elected Secretary to the Mathematical and Physical Class of the Munich Academy, and continued in the office till the time of his death.

With a budget of only 4500 florins, Martius succeeded, with the assistance of the highly meritorious gardener Weinkauff, in making the Botanic Garden a model establishment. The Garden had just been rearranged with great care, and partially replanted, when in 1854, by the erection of a glass building for an industrial exhibition, the beautiful plan was marred. Martius, who had vainly remonstrated against this intrusion, ceased to

interest himself in the garden; and his principal occupation thereafter was the publication of the 'Flora Brasiliensis.'

Whatever the world could offer in acknowledgment of his merits Martius received. He was elected member of nearly all the academies and learned bodies in Europe, and kings and emperors honoured him with the most distinguishing marks of favour. His election as Foreign Member of the Royal Society was in 1838. He rejoiced in the esteem and friendship of his most distinguished contemporaries; and plants and animals, and even a mountain (Mount Martius in New Zealand), were named in his honour. But the most gratifying expression of homage and veneration was presented to him on the 30th of March, 1864, the 50th and jubilee anniversary of the day on which he was invested with the degree of Doctor. His friends caused a medal to be struck, with the inscription, "Palmarum patri dant lustra decem tibi palmam. In Palmis resurges." And on the 15th of December, 1868, the remains of the departed were lowered into their last resting-place bedecked with Palm-leaves.

General Thomas Perronet Thompson was born at Hull, on the 15th of March, 1783, the eldest of three sons of Thomas Thompson, Esq., a merchant and banker of that town, and for several years M.P. for Midhurst. His mother was the grand-daughter of the Rev. Vincent Perronet, vicar of Shoreham in Kent, a Swiss Protestant by descent, and one of the few clergymen of the Church of England who joined John Wesley at the commencement of his mission. The youth's early education was received at the Hull grammar school, under the Rev. Joseph Milner, author of the "Ecclesiastical History;" and in October 1798 he entered Queen's College, Cambridge, where in due time he took his B.A. degree with the honour of Seventh Wrangler—no bad start in life for a boy under nineteen.

In 1803 he sailed as a midshipman in the 'Isis' of 50 guns, the flagship of Vice-Admiral (afterwards Lord) Gambier, on the Newfoundland station, and was shortly after put in charge of a West-Indiaman recaptured in the mouth of the Channel, and ordered with other prizes to Newfoundland, where she arrived, the only one that had stuck by her convoy through those foggy latitudes. In the following year he received information of having been elected to a Fellowship at Queen's, "a sort of promotion," he remarks, "which has not often gone along with the rank and dignity of a midshipman." Trafalgar, for which he saw Nelson embark on board the 'Victory' at Portsmouth in September 1805, closed the prospect of active service in the navy, and in 1806 he joined the "old 95th Rifles" as a second Lieutenant, and was among the prisoners captured, together with General Crawford, by the Spaniards in the Convent of San Domingo, in Whitelock's attack on Buenos Ayres, on the 5th July, 1807.

After his liberation and return to England he was sent in the spring of 1808, at the age of twenty-five, as Governor, to Sierra Leone, through the influence of Mr. Wilberforce, an early friend of his father's. Here his

efforts to put down the Slave Trade, which secretly existed under the name of "apprenticeship," marked the man who ever after stuck "closer than a brother" to the dark-skinned races of the earth. "There was no time for hesitation" (he wrote long afterwards). "Of two things he must do one, either withdraw under the pressure of the acknowledged danger of meddling with a dishonest system, or push forward for the present abatement of the mischief, with the almost certainty of being abandoned by the government at home." He chose the latter, and was recalled. When the official documents connected with his proceedings were subsequently required for discussion in Parliament, reply was made that they *could not be found.*

After marrying, in 1811, Anne Elizabeth, daughter of the Rev. Thomas Barker, of York, he joined the 14th Light Dragoons in Spain as Lieutenant, and was present at the actions of Nivelle, Nive, Orthes, and Toulouse, for which he received the Peninsular War-medal with four clasps. During the campaign of 1814 he was taken off regimental duty and attached to the staff of General (afterwards Sir Henry) Fane, of whose kindness and ability be preserved a grateful recollection. "Some old dragoons, discharged on eightpence a day," he writes of himself, "may remember that he was a careful leader of a patrol, a good look-out on picquet, could feel a retiring enemy, and carry off a sentry for proof, as well as another, a great hater of punishment, and a man of very small baggage, consisting of something like a spare shirt and an Arabic grammar."

His youngest brother, Charles, B.A. and Travelling Bachelor of Queen's, and Lieutenant and Captain in the 1st Foot Guards, was killed in action at Biarritz, in the South of France, on the 12th December, 1813; and the survivor, in the irresistible desire of seeing his face once more, had him taken up a few days after and reinterred in the garden of the Mayor of Biarritz, where he rests among the strawberry beds with two other officers of the same regiment, over whose graves the gallant Frenchman has placed a stone with an appropriate French inscription. This striking incident was commemorated by the muse of Amelia Opie, who on this occasion felt as a friend, a relative, and a poet.

Promoted at the peace of 1814, Captain Thompson exchanged into the 17th Light Dragoons, serving in India, where he improved his knowledge of Arabic, which he had begun to study as a subaltern of dragoons in Spain. Arriving at Bombay in 1815, he soon after served in the Pindarry campaign, and had charge of the outposts of the force under Sir William Grant Keir, whom he accompanied in 1819 as Arabic interpreter to the expedition against the Wahabees of the Persian Gulf. In this capacity he assisted at the reduction of Râs al Khyma and other places on the coast, and had a prominent part in negotiating the treaty with the defeated tribes, the most remarkable article in which was the declaring the Slave Trade to be piracy; the earliest declaration to that effect in point of time, though the American one reached England first (see "Exercises," vol. iv. p. 29).

When the main body of the expedition returned to Bombay, he was left in charge of Râs al Khyma with 1100 men, Sepoys with a detachment of European artillery, and was eventually ordered to demolish the town, and withdraw the troops to the island of Kishme on the Persian coast. A misunderstanding having arisen between the Bombay Government and the Arabs of Al Ashkerch on the coast of Omân, who had plundered certain boats, the former sent an order to Captain Thompson to act against them from Kishme in the event of their clearly appearing to be piratical, but to address a letter to them previously to any attack being made. This attempt at negotiation failing through the murder by the hostile tribe of the messenger bearing the letter, the injunction to communicate appeared to be fulfilled and answered. Few will see any alternative but to execute the orders to act; and military men will comprehend the duty of acting with decision under the circumstances which had arisen. Landing at Soor, on the Arabian coast, forty-six English miles from the town of the hostile tribe of Beni Bou Ali, Captain Thompson's small force of 320 Sepoys and four guns was joined by the Imâm of Maskat with 2000 men of his own. The force of the enemy was reported to be 900 bearing arms. On the 9th November, 1820, as the column was toiling through the sand, the hostile sheik, Mohammed Ben Ali, advanced to the attack, sword in hand. What followed is best described in Captain Thompson's own words, written in a private letter the next day:—"The Arabs made the guns the point of attack, and advanced upon them. The instant I heard a shot from the light troops, which showed the Arabs to be in motion, I ordered the Sepoys to charge with the bayonet. Not a man moved forward. I then ordered them to fire. They began a straggling and ineffectual fire, aided by the artillery, the Arabs all the while advancing, brandishing their swords. The Sepoys stood till the Arabs were within fifteen yards, when they turned and ran. I immediately galloped to the point where the Sepoys were least confused, and endeavoured to make them stand; but they fired their musquets in the air and went off. The Imâm's army began a fire of matchlocks, and went off as soon as the Arabs approached. I rode to the Imâm and found him wounded. The people just ran like sheep. I saw some of the European artillerymen, and ran to endeavour to make them stand; but they were too few to do anything."

In the midst of the *mêlée* the writer was struck on the shoulder by a matchlock ball, which passed through coat and shirt, grazing the skin, as he used to say, "like the cut of a whip." The loss of the force in men and guns was most severe, "as must always be the case," he observes, "when troops wait to be attacked with the sword and then give way." The remnants were at length rallied at the town of Beni Bou Hassan, about three miles from the scene of action, and after repulsing a night attack, were led back overland to Maskat by Captain Thompson in person, eight days after the fight.

Another expedition was quickly sent from Bombay. The town was

taken, and the defenders were conveyed as prisoners to Bombay, where, at the meeting between the captive sheik and his original assailant, they agreed heartily on one point, that it would have been a happy thing for both if the letter, lost by the murder of the messenger, had reached its destination.

A court-martial followed, as usually happens in cases of disaster, however undeserved. He was "honourably acquitted" of the two graver charges affecting his personal conduct, and only "found guilty" of so much of the remainder as, in the opinion of the Court, warranted a reprimand for "rashly undertaking the expedition with so small a detachment," and for "having addressed an Official Report to Government, in which, from erroneous conclusions, he unjustly and without foundation ascribed his defeat to the misbehaviour before the enemy of the officers and men under his command." The Report alluded to is in the Supplement to the 'London Gazette' of the 15th and 18th May, 1821 (copied in the 'Times' of the 19th), and may be usefully compared with the finding of the Court.

Their position no doubt was painful, as standing between the incensed Bombay Government and its unsuccessful officer; and it was difficult to reconcile the logic of facts with a natural regard for the wounded feelings of the Company's service. The wars of Affghanistan, Sind, the Punjab, and the Mutiny had not taken place to prove the inferiority of Sepoys to a hardier race; and Indian public opinion was slow to believe anything to their disadvantage. Under these circumstances, and viewed by the light of subsequent experience, the result of the trial was alike honourable to the Court and to the accused; but it nearly broke his heart at the time, and left traces for life on his mind and spirits. Yet it is characteristic of his generous disposition that he retained no prejudice against the Sepoys as a body; and when they were punished, as he thought, with undue severity after the mutiny, his voice and pen were vigorously exerted in their behalf.

In 1822, his regiment being ordered home, Captain Thompson returned with his wife and child by the Red Sea, Cosseir, Thebes, the Nile, Cairo, and Alexandria, through Italy and France. The "overland route" of that day was a very different undertaking from what it is now; and the voyage, performed in country vessels, was protracted by contrary winds, so that more than a year was consumed in reaching England. In 1827 he was promoted to a Majority in the 65th Regiment, then in Ireland, and in 1829 to an unattached Lieutenant-Colonelcy of Infantry. His subsequent promotions bore date, Colonel 1846, Major-General 1854, Lieutenant-General 1860, and General 1868.

And now, after his return to England, commenced the literary and political portion of his life. To the first number of the 'Westminster Review' he furnished the article on the " Instrument of Exchange," the result of eleven years' continuous study. In 1829 he became virtually the sole proprietor; and beginning with the article in support of Catholic Emancipation, of which 40,000 copies were dispersed under the title of the

"Catholic State Waggon," he continued to write at the rate of three or four articles per number, making upwards of a hundred in all, till the Review was transferred in 1836. In 1825 he wrote, to serve the Greek cause, two pamphlets in modern Greek and French on the service of outposts, and on a system of telegraphing for field service. In the following year he published the 'True Theory of Rent,' in support of Adam Smith against Ricardo and others; in which view he was borne out by Say. And in 1827, eleven years before the Anti-Corn Law League was formed, and when he was only a Major in a marching regiment, he published his celebrated 'Catechism on the Corn Laws,' a work which went through many editions, and to which Mr. Cobden always acknowledged the obligations of the Free Trade cause. "For breadth of principle," says a generous political opponent, "humorous and telling illustration, a strong racy Saxon style, there is nothing in Cobbett superior to this little pamphlet."

He was elected a Fellow of the Royal Society in 1828. The following year he wrote "Instructions to my Daughter for Playing on the Enharmonic Guitar; being an attempt to effect the execution of correct harmony, on principles analogous to those of the ancient Enharmonic." He followed this up by the construction on the same principle of an Enharmonic Organ, which was shown at the Great Exhibition of 1851, and "honourably mentioned" in the Reports of the Juries. In 1830 he published 'Geometry without Axioms,' being an endeavour to get rid of Axioms, and particularly to establish the Theory of Parallel Lines without recourse to any principle not founded on previous demonstration. The work went through several editions, with successive amendments, but attracted more attention in France than here; and an accurate translation was published by M. Van Tenac, Professor of Mathematics at the Royal Establishment at Rochefort, and subsequently attached to the Ministry of Marine at Paris. In 1830 he also published a pamphlet on the 'Adjustment of the House of Peers,' which obtained the remarkable compliment of being republished in Cobbett's Register. The same year, at the invitation of Jeremy Bentham, he edited the Tenth Chapter (on military establishments) of his "Constitutional Code," and wrote the notes and "Subsidiary Observations" at the end. In 1834 he published at Paris, in answer to the *Enquête*, or Commercial Inquiry then carried on by the French Government, the "Contre-Enquête; par l'Homme aux Quarante Ecus;" in which the principles of commercial freedom were developed under a familiar form. In 1842 he collected all his writings in six closely printed volumes, under the title of "Exercises, Political, and others,"—a mine of literary, political, military, mathematical, and musical information. This was followed, in 1848, by his 'Catechism on the Currency,' the object of which is to show that the best currency is one of paper, inconvertible, but limited. The views set forth in this publication are embodied in a motion of which Colonel Thompson gave notice in the House

of Commons on the 17th July, 1850, and in a series of twenty-one Resolutions which he moved in the House on the 17th June, 1852, and which were negatived. (3 Hansard, cxxii. 899). His 'Fallacies against the Ballot,' afterwards reprinted as a "Catechism," first appeared in 1855.

At the general election in January 1835, he polled 1386 votes at Preston without being present. In June following he was elected, after a sharp contest, by a majority of five, for Hull, his native place, and was, as he expressed it, "laid down and robbed at the door of the House of Commons" to the amount of £4000 by a petition of which none of the charges were proved before the Committee. While in Parliament, both at that time and afterwards, he maintained a constant correspondence with his constituents, addressing them generally twice a week through local newspapers in short and pithy reports, which were republished under the title of "Letters of a Representative," and "Audi Alteram Partem," this last consisting chiefly of an indignant commentary on the measures taken to suppress the Indian Mutiny. He was also an active promoter of the abolition of corporal punishment in the army, and an opponent of the restriction of marriage with a deceased wife's sister.

Defeated at Maidstone by Mr. Disraeli in 1837, and subsequently at Marylebone, Manchester, and Sunderland, he was elected in 1847 for Bradford, again defeated there in 1852 by six votes, and finally, in 1857, returned without a contest. The dissolution of 1859 closed his career in Parliament, for which he never stood again, although he continued to write in various periodicals on public matters under the signature of "An Old Reformer," and latterly as "A Quondam M.P.," in strenuous defence of the Irish Church. As one of the leaders of the Anti-Corn Law League, the pioneer and fellow-labourer of Cobden and Bright, he will live in the grateful remembrance of many whose cheap loaf is due to the Father of Free Trade, "the literary soldier who wrote the 'Corn Law Catechism.'"

In person he was short, active, and well made, and in middle age might be, as he described himself, "stouter than would become a Light Dragoon;" but he was capable of much fatigue, and insensible to irregularities of hours and seasons. Of his acquirements and ability the foregoing sketch may give some idea; but only those who knew and loved him in private life can tell the depth of his learning, of his goodness, benevolence, and kindness of heart. After a life so long, so varied, and at times so stormy, his end came peacefully at Blackheath, early on the 6th of September, 1869, in the 87th year of his age. He had written letters on various subjects, including his favourite Enharmonic Organ, up to the middle of the day before, in full possession of his mental and bodily faculties, and he may be said to have died, as he lived, pen in hand—"*Qualis ab incepto.*" He was followed by his children and grandchildren to Kensal Green, where he rests not far from an old friend and fellow reformer, Joseph Hume.

In the list of Fellows lost to the Royal Society this year, the name Thomas Graham stands out with great prominence. Much as he was known, and widely, he was little seen in what may be called the social circles of scientific life; and although we shall miss him and his work in a field which he alone seemed to cultivate and understand, and although his work must greatly influence science, and through it civilization, the public will not observe that any name of importance is absent on great occasions or in large meetings.

He was born in Glasgow, in 1805, Dec. 21st. His father was a merchant of that city, and gave him every opportunity of learning. Having attended the primary school, he went at nine years of age to the Grammar School for Latin and Greek under Dymock, for the usual term of four years, and under the rector, Dr. Chrystal, for the finishing year. Then he went to the University, at an early age certainly, but such is the custom of the place. We hear of no great feats of scholarship in the Grammar School. Graham was too quiet to be brilliant. We hear of diligence, and that he occupied a seat in the first form, and got prizes for lessons as well as a prize every year for not having been absent for one day. The education at this school was sound, and it was not easy for a boy to leave it without some useful knowledge of the languages taught, as well as a very clear idea of the history and progress of the world. In college he remained for seven years before taking his degree of M.A. in 1826. At that time the university was too much of a high school, but it was of course obliged to suit itself to the young who attended. It is clear that Graham had his whole time occupied at the best schools of learning around him, and many must still remember his teacher in chemistry, Dr. Thomas Thomson, and in physics, Professor Meikleham.

His attention seems to have at this time been devoted for the most part to physics and mathematics. When he had taken his degree, he was expected to enter on distinct professional studies. His father had designed him for the church, but his mind was bent on the study of science. A struggle took place between two strong wills, and caused him much misery for many years. Neither was accustomed to speak his mind, otherwise the great respect which each had for the other would have been discovered sooner for the good of both.

This sorrow was softened to Graham by the great tenderness of his mother, to whom he was most devoted, and to whom he told, in a long series of confiding letters from Edinburgh, where he now went to study, all his doings and feelings. In these letters we are led to hope for a very full picture of the early manhood of Graham. It was at this time that he learnt isolation, and satisfied his love of sympathy by writing, so that he acquired a habit which never left him. It is in these notes, reaching up to his last illness, that we must look for all that he thought on scientific and other subjects; and they, with his published papers, will constitute his true autobiography. Few stirring events happened to him; his life, externally

at least, was calm; and equally calm was his mode of thinking, as evinced in his numerous scientific memoirs. He stayed in Edinburgh, studying with Dr. Hope, the well-known Professor of Chemistry, for two years, and there made the acquaintance and enjoyed the friendship of Leslie. Returning to Glasgow, he began to teach mathematics; he then took a room for a chemical laboratory in Portland Street, and in this he gave lectures, for a very short time only, as he was Lecturer in the Mechanics' Institute for the winter 1829–30, having succeeded Dr. Thomas Clark, afterwards Professor in Aberdeen. In the latter year he was transferred to the Andersonian Institution, succeeding Dr. Ure, who went to London.

Graham began in Glasgow with the good wishes of all who knew how laboriously he had studied. He was then 24 years old, but he had been known to scientific men for three years previously; his earliest memoir bearing date 1826, and one on diffusion of gases 1829. He appeared extremely young, and like a boy beginning to teach. He was not fluent in speech; there was a hesitation as if it were difficult to find the proper word, and a quietness of demeanour which (except for the little perceptible nervousness) completely covered the great enthusiasm which kept him at constant work for forty years after that period. He remained in Glasgow lecturing and teaching in the laboratory till 1837, and sending out diligent workers who have since shown themselves vigorous in the regions of science and its application to the Arts. In that year he went to London as Professor at the London University, now University College. He had his residence near it in Torrington Square, which he afterwards left for a house a few doors distant, at 4 Gordon Square, where he ended his days on the 16th of September, 1869. In the College he was held in high regard by his pupils and colleagues. It is true that, as a lecturer, he had to contend with a want of natural fluency and with a feeble utterance; but as he had always the clearest conception of the matter he was treating of, his manner of exposition, even of intricate subjects, was singularly clear and perspicuous, and the instruction imparted was well grounded and thorough, and was pervaded by the same philosophical spirit which guided him in his original investigations.

In 1855 he ceased to be connected with the College, having succeeded Sir John Herschel as Master of the Mint.

An occasional visit to Scotland to see his relations, sometimes to Ballewin at Strathblane, a property which his father had left him, made up his chief journeys, and in later years he was afraid to go except in June or July. His chest, as indeed his whole constitution, was tender, and the accidental exposure to an open window in a warm August day brought on his final attack.

Were it possible to write at present a correct account of Graham's intellectual life, the space required would be too long for this occasion, and a short notice will be given of his principal papers only.

His earliest memoir indicated in the 'Royal Society's Catalogue' is in

Thomson's 'Annals of Philosophy,' 1826, "On the Absorption of Gases by Liquids." He there reasons out the idea that gases are converted into liquids by mixing with or being absorbed by liquids, and that the phenomenon becomes simply that of two liquids mixed together. He concludes that gases may owe their absorption by liquids to their capability of being liquefied, and to the affinities of liquids to which they become in this way exposed. These two properties are considered to be the immediate or proximate causes of the absorbability of gases. It follows "that solutions of gases in liquids are mixtures of a more volatile with a less volatile liquid." He says also that it is a coincidence more than accidental that the gases which yielded to condensation in Mr. Faraday's hands are, generally speaking, of easy absorbability. He objects therefore to Henry's law, that the quantity of gas which water absorbs is directly proportionate to the pressure, because it is not likely that this law would have been spoken of had such gases as muriatic acid been employed, that being very readily absorbed, although there might be an approximation to such a law when the quantity of gas absorbed was inconsiderable.

Graham illustrated the condensation and solution of a vapour in a liquid by supposing steam of the heat of 600° F. to be passed through sulphuric acid of 600° F., when he doubted not immediate absorption and actual solution would take place, as if water and sulphuric acid were mixed at lower temperatures; and yet the steam would be brought into the condition of a liquid which by ordinary cooling would have taken place only after nearly 400° diminution of temperature.

So late as 1866, speaking of the dialytic separation of gases through colloid septa, he is desirous of showing that the flow is not that of diffusion or of effusion, or of transpiration, but that of a liquid absorbed by one side and passed to the other; and in 1868 he illustrates the passage of hydrogen through palladium by saying that it is analogous to liquid diffusion through a colloid. There are forty years between the beginning and end of this train of thought.

This is a fair specimen of Graham's habit of mind and of his perseverance. He seems to have begun life with an intense desire to know the inner structure of matter, stimulated to understand more than the atomic theory could give him, but nevertheless a true student of Dalton. Born in 1805, when Dalton was preparing for the press the ideas he had already given in lectures, he seems to have been destined to begin a new line of work closely allied to that which Dalton had done.

It is almost painful to think of the attempts of mankind to understand why bodies should have a definite composition, and Dalton's simple idea of adding atom to atom not only made it appear possible, but showed why the contrary should be most improbable. Now it seems so simple that some men believe it was scarcely a discovery, whilst every chemist is slavishly bound to it in some form or other, unable either in practice or theory to escape; and this point seems now to be true for all time. Still the simple

axiom, so to speak, was not a science; and as one proposition after another arises out of it, the first idea itself appears grander and grander. Dalton, like Newton, used the term atom as meaning a particle which could not be divided by any force. But there seems no need to say that it could not be divided by the imagination or even by new forces, in which case it becomes the practical as opposed to the theoretical atom. Under the present chemistry there probably exists another which shall deal with the broken atom of our present science; we do not know how many layers there may be under it. It is strange that Dalton's idea was so purely mechanical, although illustrating a purely chemical act: there is no talk of obscure forces; it is a movement like a carpenter's, a fitting of pieces in the manner of a workman. Graham took up the subject in the same spirit, and seems to have during his whole life sought for nothing beyond the knowledge of the constitution of matter, and the mode in which the atoms or molecules move. His favourite word is molecule, not atom; indeed he seems too guarded to use the latter in any case of measurable movement. His destiny was to follow the progress of the molecule, and to show that there were movements in bodies which depended on that aggregration of atoms, whether ultimate atoms or not. Whilst Dalton showed the relative weights of the combining quantities, Graham showed the relative magnitude of groups into which they resolved themselves.

Having discovered that solid bodies could be divided into two classes, colloid and crystalloid, and that the first consist of substances existing in great varieties of conditions, and apt to undergo long and remarkable progressive changes, he seems to have taught us the way to obtain many substances practically new, although nominally such as we have seen. Whilst one, the colloid, has power of motion in itself to a considerable extent, the other, the crystalloid, has power of motion in solutions, so that we are introduced to a series of new forces, the end of which is not in the faintest way foreseen. The door by which we enter these strange regions is found by a series of the most uninviting trials; it seems to have been hidden under the most homely brushwood, and few would think of toiling so long in such a field.

It may be well to go over some of his principal papers, and to observe how constantly he kept to these ideas whilst penetrating further into the subjects.

In 1827 he observed that phosphate of magnesia effloresced very readily; this, he argued, proved a weak affinity for water; if weak, heat ought to destroy it, and so he found that it was thrown down anhydrous on boiling. He argues that it is only the hydrate that is soluble, properly speaking, in other cases also.

This led him, in 1835, to examine the hydrate, when he found that the tendency of phosphate of soda to combine with an additional dose of soda was connected with the existence of closely combined water. This induced him to separate the water of salts into two parts, crystalline and basic, the

first being easily removed, the second requiring more than the boiling-point of water to remove it. This atom of water may be replaced by a salt, forming a class of double salts. Amongst the salts with basic water he puts sulphuric acid as sulphate of water, and an additional atom as equal to the atom of crystallization.

In the same year he speaks of ammonia performing the function of water in compounds of copper. In 1836 he says that his "researches make it probable that the correspondence between water and the magnesian class of oxides extends beyond their character as bases, and that in certain subsalts of the magnesian class of oxides the metallic oxide replaces the water of crystallization of the neutral salt and discharges a function which was thought peculiar to water." The inquiry was extended to the constitution of the phosphoric acids, and the amount of base taken up by them shown to be equivalent to the amount of water in the acid; from this he passed to the arseniates. It is quite evident that he treated water as he treated metallic oxides; indeed he speaks of metallic oxides performing the functions or taking the place of water. It was a distinct recognition of hydrogen as a metal in its place in salts, whilst his latest paper in 1869 endeavours to establish its specific gravity when combined with palladium as an alloy.

This was one of the chains of discovery which, at an earlier period, led to the doctrine of substitution. It is still sound; and although the water does not now hold the same place of honour in the phosphorus acids, the place is held firmly by the hydrogen, which takes its position as a metal. This idea cannot be regarded as originating with Graham; Davy seems to have hinted it, and Dulong made it distinct; but it was Graham whose careful experiments and cautious reasoning gave it consistency and force, although he himself did not actually adopt it in general teaching. Probably nothing tended so much to give hydrogen its present place as the inquiry into the constitution of the phosphates, and his explanation of the monobasic, bibasic, and tribasic acids.

We have the first results of his experiments on diffusion in the Philosophical Magazine for 1829.

After giving various details of experiments he says, "It is evident that the diffusiveness of gases is inversely as some function of their density, apparently the square root of their density." This is the conclusion he arrived at finally.

The separation of gases by simple diffusion is shown to be practicable, and is there illustrated; he mentions it as conceivable "that imperceptible pores and orifices of excessive minuteness may be altogether impassable (by diffusion) by gases of low diffusive power, that is, by dense gases, and passable only by gases of a certain diffusive energy." Here we observe his wonderful caution: he will not say that the atoms or molecules may be too large, he will not say that the gas will not pass, but he says "impassable (by diffusion)."

In his paper read before the Royal Society of Edinburgh, Dec. 19th, 1831, he goes more fully into his favourite subject, beginning with firmness. "It is the object of this paper to establish with numerical exactness the following law of the diffusion of gases." "The diffusion or spontaneous intermixture of two gases in contact is effected by an interchange in the position of independent minute volumes of the gases, which volumes are not necessarily of equal magnitude, being in the case of each gas inversely proportioned to the square root of the density of that gas."

In this paper (1831) he also tried the speed with which gas passed through stucco under pressure.

In 1846 Graham read to this Society a memoir "On the Motion of Gases." There he showed what he called the effusion of gases into a vacuum through a thin plate ($\frac{1}{228}$ of an inch thick), "leaving no doubt of the truth of the general law, that different gases pass through minute apertures into a vacuum in times which are as the square roots of their respective specific gravities, or with velocities which are inversely as the square roots of their specific gravities," and that "the effusion-time of air of different temperatures is proportional to the square root of its density at each temperature." The remarkable results of transpiration are fully developed in his second paper (June 21st, 1849) "On the Motion of Gases."

If a tube of a certain length be used to allow the escape of the gas, the velocities of the gases attain a particular ratio which remains constant with greater lengths and resistances. This ratio depends on a new and peculiar property of gases, which he called Transpiration. He considered that solids have many modes of showing their character, the varieties of structure being endless; but gases could only show theirs in a few directions, and he believed that the ratios of transpirability would have a simplicity comparable to that of the specific gravities, or even the still more simple relations of the combining volumes. As gases, compared with solids, are capable of small variation in physical properties, those characters which do show themselves may well be supposed to be the most deep-seated and fundamental with which matter is endowed. He adds, "It was under this impression that I devoted an amount of time and attention to the determination of this class of numerical constants which might otherwise appear disproportionate to their value and the importance of the subject. As the results, too, were entirely novel, and wholly unprovided for in the received view of the gaseous constitution, of which, indeed, they prove the incompleteness, it was the more necessary to verify each fact with the greatest care." As examples, the density of nitrogen is 14 when hydrogen is taken as 1; but the transpiration velocity of hydrogen is exactly double that of nitrogen. The transpiration time of carbonic acid is inversely proportional to its density, when compared with oxygen. These results he believed to show "the important chemical bearing of gaseous transpirability, and that it emulates a place in science with the doctrines of gaseous densities and combining volumes."

This remarkable property of gases was viewed by Graham as a result of one of the initial endowments of matter, and in this search he showed his usual desire of approaching nearer than we had ever done to the actual constitution of the primitive molecule and practical atom. These inquiries on the motion of gaseous molecules led Graham to look at the motion of bodies in solution or "liquid diffusion." The first paper was read in 1849. He naturally connected this with his earlier experiments on the phosphates, and the amount of water held by them and phosphoric acid; and he termed solubilities of substances weak and strong, as well as great or small. He supposed that this varying strength of solubility might arise from a greater or less diffusive power.

Graham believed liquid diffusion to have an analogy to evaporation; and as the squares of the times of equal diffusion of gases are in the ratio of their densities, so by analogy it might be inferred that the molecules of the several salts, as they exist in solution, possess densities which are to one another as the squares of the times of equal diffusion. He attributed the diffusion of substances in solution, like the transpiration of gases, to a fundamental property of bodies. The pith of the inquiry is thus stated:—"The fact that the relations in diffusion of different substances refer to equal weights of these substances, and not to their atomic weights or equivalents, is one which reaches to the very basis of molecular chemistry. *In liquid diffusion we deal no longer with chemical equivalents or the Daltonian atoms, but with masses even more simply related to each other in weight.* Founding still upon the chemical atoms, we may suppose that they can group together in such numbers as to form new and larger molecules of equal weights for different substances; or, if not of equal weight, of weights which appear to have a simple relation to each other. It is this new class of molecules which appears to play a part in solution and liquid diffusion, and not the atoms of chemical combination." He seems glad to obtain the densities of a new kind of molecules, although knowing no more respecting them. One result is the formation of classes of equidiffusive substances; these, again, led to a new mode of analysis in 1861, and a new division of soluble bodies. It was observed that the power of diffusion of a solution of albumen was very small, 1000 times less than that of common salt; and this fact led to an examination of numerous substances, when it was found that they divide themselves into two classes without respect to organic nature; one is colloid, and includes gelatine and gelatinous silica, alumina, albumen, gums, sugar, starch, and extractive matter. The plastic elements of the animal body are found in this class; and here Graham uses the word (as, indeed, he uses all words) in a very exact sense, that which has the power of forming.

Continually seeking the origin of chemical action, he ascribes to bodies possessing this colloidal condition a dynamical character. They are slow in changing, but seem in a continual change. They possess *energia*, and may be the primary source of the force appearing in the phenomena of

vitality; and to these gradual colloidal changes may be referred the characteristic protraction of chemico-organic changes. These colloid bodies are very easily penetrated by the soluble crystalloid bodies to which they are opposed, and they form a medium also of separation or dialysis.

This process of dialysis has a high value in the explanations it affords, and promises to afford, of many physiological phenomena. But these hitherto unknown and still obscure properties of molecules seem destined to lead us still further on; and by presenting to us a nearer view of the fundamental phenomena, they give us an idea of the enormous magnitude of the structure under which they seem to lie. Graham believed that the rate of diffusion held a place in vital science not unlike the time of the falling of heavy bodies in the physics of gravitation.

In a paper "On the Molecular Mobility of Gases," June 18th, 1863, he further compares several substances as to their facilities for diffusion, and defines clearly the effusion-rate and the transpiration-rate as distinct. A substance suiting the purpose of diffusion is graphite.

He obtained by the graphite diffusiometer a separation of oxygen from the air, making a mixture with 2 per cent. additional of that gas. This led him to try another mode; and by lengthening the surface and tube, he obtained $3\frac{1}{2}$ per cent. more oxygen than in the atmosphere. This process he calls atmolysis. Trying diffusion without an intervening septum, he found that carbonic acid had proceeded half a metre length in seven minutes.

The separation of gases was carried out much further, and described in a paper read June 21st, 1866. Here he begins the use of caoutchouc, having been led to it by the experiments of Dr. Mitchell, of Philadelphia. He found that air drawn through sheet rubber contained as much as 41·8 oxygen, the theoretical speed being 40·46, deduced from the passage of the separate gas. He is desirous of showing that in this case the flow is different from diffusion; it is caused by an absorption of the gases, which are taken into the caoutchouc in a liquid state, and are then given out on the opposite side.

This inquiry naturally led to an examination of the absorption by metals. Deville and Troost had discovered that platinum and iron absorbed gases when hot. Graham found hydrogen to pass through heated platinum 1·1 millim. thick at the rate of 489·2 cub. centimetres per minute on a square metre. Oxygen scarcely passed, and other gases tried did not pass. Wrought platinum took up 5·53 vols. of hydrogen, which, on cooling, were shut up or occluded in the mass. Fused platinum took only 0·171 vol.; hammered platinum 2·28–3·79. Palladium, however, was most remarkable, as it took up 643 vols. of hydrogen; in a later paper the quantity is stated to be 935 vols. These gases were pumped out from the reheated, but could not be removed from the cold metal. Palladium cold, however, was found to take up hydrogen when it was used as the negative pole of a galvanic battery, and spongy palladium, which had absorbed hydrogen when heated, deoxidized some salts in the cold.

Iron manufactured, or from telluric sources, was found to contain carbonic oxide.

Silver, gold, copper, osmium-iridium took up little gas, and antimony no hydrogen. He divides the metals into crystalline and colloid.

His paper of May 16th, 1867, enters more fully into the subject, and shows that meteoric iron contains hydrogen, with the probability, if not certainty, that it was cooled in an atmosphere of that gas. Messrs. Huggins and Miller, as well as Father Secchi, had concluded that hydrogen is one of the gases shown on the spectrum of the fixed stars, and especially mentioned it as found with the unusual increased light of T Coronæ in November 1866. The actual handling of the gas brought from distant space was a strange experimental proof, and was remarkably characteristic of Graham's peculiar inclination to place his work before his thought. He seemed to feel his way by his work. He was not able to impregnate iron with above one volume of hydrogen, whereas the meteoric iron contains at least three. He thinks this shows that it may have been absorbed under pressure.

On May 22nd, 1868, he showed that palladium took up 0·723 per cent. by weight of hydrogen; and he inclines to believe that the passage of the gas through palladium is analogous to liquid diffusion through a colloid.

As a private man, Graham led an uneventful life; but no man has passed through the world more uniformly respected. Too retired, too quiet, his life appears to have a deep tinge of melancholy in it, notwithstanding its eminent success. Very intimate friends he had few out of the circle of the family of brothers and sisters, who were strongly attached to him, and to whom he was much devoted, being himself unmarried.

As a scientific man, his claims were never disputed; he was not called to assert his position, and he remained the undisputed head of his department. He received in early life (1834) the Keith Medal of the Royal Society of Edinburgh, and the Royal Medal of this Society in 1838, and in 1862 the Copley Medal. He was made a Doctor of Civil Law of Oxford, Honorary Member of the Royal Society of Edinburgh, Corresponding Member of the French Institute and of the Academies of Berlin and Munich, and of the National Institute of Washington. His election into the Royal Society was in 1836.

On his appointment to the Mint, Mr. Graham laboured assiduously and successfully in acquiring a thorough knowledge of the technical work and financial relations of his office, and discharged his duties with much energy and judgment. It is known that he brought about various reforms and economies in the working of the establishment; but the service for which he will be chiefly remembered was the introduction of the new bronze coinage, which, besides substituting a more convenient medium of circulation than that in previous use, was attended with a pecuniary profit to the state of very large amount.

An old and valued friend of Graham, Dr. A. W. Hofmann, then intimately associated with him, thus speaks of his administration of the Mint*:—"It would be difficult, within these narrow limits, to convey an adequate notion of the great and manifold activity exercised by Graham in the high office entrusted to him. The new chief of the Mint soon showed a vigilance, a knowledge of the work, an amount of industry and energy, and, when called for, an unsparing severity which astonished all, and especially some of the officials of the establishment. Such requirements had not heretofore been exacted, nor such control exercised. The new Master's love of innovation, and his disturbance of settled arrangements (for in such light was his action viewed), had to be resisted with every effort. The author of this sketch at that time held an office in connexion with the English Mint, and was therefore witness, though from without, of the struggle which Graham had to go through in his new position. It was years before he finally overcame these difficulties, and was enabled to return to his favourite study."

Graham, besides the memoirs mentioned and omitted here, wrote a system of chemistry. The second edition is still valuable; it explained at a very early stage theories which are now general, although it did not actually adopt novel arrangements. The book is a masterpiece of clearness in arrangement and style, but it was written so slowly that the publisher said that to press him was like drawing his blood. The anxiety to be correct was painful. It gives a calmness to all his writing, but really goes too far, as it rather represses the enthusiasm of the reader, and diminishes the force of the words. He may be said never to speculate till he has made experiments; he seems to feel the forms with his fingers before he ventures to describe them; but he reaches to utmost space in this manner more surely than others have done by the boldest imagination. He is, however, capable of the widest generalizations, and these he makes at times with surprising speed.

When speaking of liquids, Graham has been quoted as saying that the rate of diffusion held a place in vital science not unlike the time of falling bodies in the physics of gravitation. We judge of the value of discoveries by the fruit they produce; when we do so, it requires some time to judge fairly. Although there seems to us a boundless region opened up, it is not yet traversed; perhaps he who opened it was best able to see its extent. By his experimental examinations of the motion of molecules, he has made a step which before was left to reason only; and unless he can be shown to have made a mistake, we do right (whilst associating him with other illustrious men of former times) to connect him more closely with his most direct predecessor, Dalton. With such distinguished names, therefore, it seems just that we should, until the world shall teach us better, leave that of Thomas Graham.—R. A. S.

* In a masterly discourse on Graham's life and scientific work, delivered before the German Chemical Society in Berlin, Dec. 11, 1869.

Marie-Jean Pierre Flourens, elected Foreign Member of the Royal Society in 1835, was born at Maureilhan, near Béziers, Department of Hérault, in April 1794. He studied Medicine at Montpellier, where he took his Doctor's degree at the age of nineteen, and in the year following went to Paris. There he made the friendship of various eminent men, —of whom are noted especially Chaptal and Frederick Cuvier,—and devoted himself to the pursuit of Biological science, in which he soon attained reputation as a writer and original inquirer. His earliest and most important labours were directed towards the investigation of the functions of the nervous system, and on his experimental researches and writings on this department of Physiology, which continued afterwards to be his favourite pursuit, his scientific reputation may be said mainly to rest. The first fruits of these researches were made known in three Memoirs presented to the Academy of Sciences of Paris in 1822 and 1823; and subsequently published in an independent work entitled "Recherches Expérimentales sur les propriétés et les fonctions du système nerveux dans les animaux vertèbrés." Paris 1824. Of this a second and greatly extended edition appeared in 1842, containing the substance of Memoirs presented to the Academy since the publication of the first edition, with applications of the author's doctrines to pathology and surgery, researches on the reunion of divided nerves, on the movements of the brain, on the pulsation of arteries, and on the effects of section of the semicircular canals of the ear—also an extension of his previous inquiries to reptiles and fish.

Following in the line of Haller, Zinn, Lorry, Saucerotte, Magendie, and others, Flourens endeavoured, by inflicting injuries experimentally on the encephalon and spinal cord, but especially by studying the effect of removal of definite portions of these organs, to assign the specific offices of the several parts of the cerebrospinal centre; and whatever difference of opinion may prevail as to some of the physiological conclusions at which he arrived, it must be admitted that his experiments, which have for the most part been confirmed by later inquirers, have served in large measure as a basis of subsequent reasoning on the subject.

On his first coming to Paris Flourens became a writer in the 'Revue Encyclopédique,' and contributed articles to the 'Dictionnaire classique d'Histoire Naturelle,' and in the course of his life published numerous papers on different anatomical and physiological subjects, besides that with which he was more enduringly occupied. The titles of these papers (up to 1863) form a goodly array in the Royal Society's Catalogue, to which we refer for details. The more notable of them are on the nutrition and growth of bone, on the structure of the skin and mucous membranes and on the epidermis and its appendages in man and animals, on the mechanism of Rumination, on vomiting in ruminants and its non-occurrence in the Horse, on the vascular connexion of mother and fœtus, &c., while some are on questions of anthropology, comparative psychology, and natural history;

but although these writings are for the most part founded on actual observation and real work, it can scarcely be said that they rise above mediocrity.

Flourens's first and most important memoir on the nervous system became the subject of a commendatory and most instructive report by Baron Cuvier in 1822, whose friendship and favour he thenceforth enjoyed. Cuvier a few years after (in 1828) intrusted Flourens (as his deputy) with the delivery of the lectures on Natural History at the College of France, and two years later appointed him in like manner to give the lectures on Human Anatomy at the 'Jardin du Roi,' in which appointment he was confirmed as Professor in 1832. In 1835 he became Professor in the College of France.

Though rising in fame, it was probably through Cuvier's influence, more immediately, that Flourens was in 1828 elected a Member of the Institute, in succession to Bosc. In 1833 he was appointed one of the perpetual Secretaries, on the retirement of Dulong. In this latter capacity he furnished from time to time eloges of various distinguished members of the Academy deceased during his tenure of office. These productions of his pen, as well as his official reports and his writings generally, were highly esteemed for their literary merit, and no doubt led to the much-coveted distinction he received of being elected into the Académie Française in 1840.

While recognizing M. Flourens's undoubted merits, we are nevertheless constrained to remark that, measured by them, his career as regards both social and scientific distinction, was singularly prosperous. Besides holding a highly influential position in affairs of science, he was elected a Member of the Chamber of Deputies for the Arrondissement of Béziers in 1837, and in 1846 he was created a Peer of France. He still, however, retained his professorship, and suffered neither honours nor revolutions to interrupt his scientific work. In his latter years he was affected with softening of the brain, ending in general paralysis, to which he succumbed, at his country seat Mont Geron, in the Department of Seine at Oise, on the 6th of December 1867. He has left three sons.

Peter Mark Roget, M.D., died on the 12th of September, 1869, in his 91st year. For the last 54 years he had been a Fellow of the Society, and during 21 of these had filled the office of Secretary. The earlier events of his life belong to a former page of the world's history, and to a generation that has passed away. He was born in London, in Broad Street, Soho, on the 18th of January, 1779.

His father, the Rev. John Roget, was a native of Geneva. When about 25 years old he came to reside in London, as Minister of the French Church in Threadneedle Street, founded by Edward VI., and was, two years afterwards, united in marriage with Catherine, only surviving sister of the illustrious Sir Samuel Romilly, then a young man of about 20, between whom

and Mr. Roget a warm friendship had arisen, together with sentiments of the highest mutual esteem. The subject of the present memoir was the only son of this marriage.

He had the misfortune to lose his excellent father very early in life. Not five months after his birth his parents were compelled to leave him in England and hasten to Geneva, on account of Mr. Roget's declining health. Two years afterwards the child was brought to them by his uncle, Mr. Romilly, who was then studying the law; and in two years more, under the same escort, the widowed mother returned to England with her son, and a daughter that had been born a few weeks only before the father's death, which event happened in May 1783.

In the following year the Rogets resided in Kensington Square, in the family of Mr. Chauvet, of Geneva, who kept a private school, where much of the character of parental intimacy was infused into the ordinary relations of teacher and pupil. Here the boy received the rudiments of education; but he was no doubt mainly indebted for his early training to the devoted care of his mother, who was admirably qualified for the task, not only by her mental acquirements, but by a systematic habit of mind, which was inherited by her son in a marked degree. At a very early age, moreover, he began the practice of self-instruction; and having conceived a strong taste for mathematical studies, which he pursued without aid or even encouragement from others, he soon made considerable progress in the elements of science.

Although from time to time returning to Kensington, Mrs. Roget and her two children spent the greater part of the ten years next after her husband's death in short sojourns in the provinces. This was an eventful period of history; and, late in life, Dr. Roget remembered how, during a summer spent at Malvern, the news arrived of the taking of the Bastille, and how while at Dover they used to see the emigrants landing from France and thanking God for their deliverance. In the year 1793, the mother with her two children took up their residence in Edinburgh, where Roget, then 14 years old, was entered at the University, which was then at the height of its fame. During the first two years of his residence there he attended the classes of Humanity (Dr. Hill), Greek (Mr. Dalzell), Chemistry (Dr. Black), Natural Philosophy (Greenfield), and Botany (Dr. Rutherford).

In the summer of 1795 his studies were agreeably varied by a tour in the Highlands, in company with his uncle Romilly and their attached friend Mr. Dumont, well known in connexion with the writings of Bentham, and as author of the 'Souvenirs sur Mirabeau.' To the early guidance of the last-mentioned companion, who took a warm interest in his welfare, and was at especial pains to aid the cultivation of his intellect, Dr. Roget was wont to attribute the enlightened principles which governed his conduct throughout life. He entered the medical school in the ensuing winter, and attended during that and the two following years, the lectures

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of Dr. Monro on Anatomy, Drs. Black and Hope on Chemistry, Mr. John Allen on the Animal Economy, Drs. Wilson and Gregory on the Practice of Medicine, Dr. Hamilton on Midwifery, Dr. Home on Materia Medica, Dr. Duncan and Mr. James Russell's Clinical Lectures, and, to his especial interest and delight, those on Moral Philosophy, by Professor Dugald Stewart, from whom he received much kindness, and for whom he always expressed a peculiar regard. While thus diligently engaged, he was in the summer of 1797 prostrated for a time by a severe attack of typhus fever, which he caught in the wards of the Infirmary, and which nearly proved fatal. On the 25th of June, 1798, he took his degree of M.D., being then only 19 years of age. The subject of his thesis, which he dedicated to his uncle Romilly, was "De Chemicæ Affinitatis Legibus." In the same year he wrote a letter to Dr. Beddoes on the non-prevalence of consumption among Butchers, Fishermen, &c., which is published in that writer's 'Essay on the Causes &c. of Pulmonary Consumption,' London, 1799.

After a summer and autumn spent in a trip to the Falls of the Clyde and the English Lakes, and a succession of visits to Dr. Darwin at Derby, Mr. Keir (the Chemist) near Birmingham, Dr. Beddoes at Clifton, and the Marquis of Lansdowne at Bowood, Dr. Roget came to London and continued his professional studies, first at Dr. Willan's Dispensary in Carey Street, and shortly after as a pupil of St. George's Hospital, where he attended Dr. Baillie's lectures in the early part of 1799. In that year he wrote a letter to Davy on the effects of the respiration of the then new gas (oxide of azote, or nitrous oxide), which communication appears in Sir Humphry Davy's 'Researches,' published in 1800.

In October 1800, Dr. Roget spent six weeks with Mr. Jeremy Bentham, who it is understood consulted him at that time upon a scheme which he was concocting for the utilization of the sewage of the metropolis. It may easily be imagined with how great an interest that most remarkable man was regarded by the young physician. In November he began to attend Abernethy's lectures at St. Bartholomew's Hospital.

At the end of the following year he went to Manchester on an engagement to travel with the two sons of Mr. John Philips of that town; and it was while thus employed that he met with an adventure which he ever after regarded as forming the great crisis of his life. The peace of Amiens having thrown open the continent to English tourists, Dr. Roget and his two pupils spent about three months in Paris in the early part of 1802, and thence proceeded in the summer to Geneva, having for their travelling companion thither Mr. Lovell Edgeworth, brother of the authoress Maria Edgeworth. There Dr. Roget found his old friend and preceptor Chauvet, and stayed for some time at his house. The succeeding winter was spent amidst the congenial society of Geneva, and in forming plans for a summer tour in Switzerland. These prospects were, however, suddenly dispelled by the news of the rupture of peaceful relations between England and France, of which country Geneva then formed a part.

This was soon followed by Bonaparte's celebrated order to arrest all the English then in France, and above eighteen years of age. On the first rumour which reached Geneva of this measure on the part of the First Consul, Dr. Roget determined to retire at once with his pupils into Switzerland; but on attempting to do so discovered, to his dismay, that the most active measures had been taken to prevent their escape. Their only course was to submit. The two Philipses were passed as under 18, but Roget was detained prisoner on *parole*.

This state of things lasted for about six weeks; and in the mean time fresh rumours reached Geneva of a contemplated deportation of the English prisoners into the interior.

While Dr. Roget was considering what steps he should take under these circumstances, he suddenly received the startling intelligence that in about a week's time all the English in Geneva were to be sent to Verdun, and that those in Switzerland were already arrested.

Dr. Roget then, as a last resource, applied to the authorities for exemption from arrest, on the ground that he was entitled to the rights of a citizen of Geneva by virtue of his descent from Genevese ancestors. This claim was fortunately admitted; and two days afterwards he saw the rest of the English, with poor Edgeworth among them, set out for Verdun.

Dr. Roget and his young companions now lost no time in leaving the country, but a long detour had still to be made ere they could reach England. The French were rapidly extending their boundaries westward, and the travellers found it necessary to proceed by way of Stuttgart, Frankfort, Leipsick, Potsdam, Berlin, Lubeck, and Husum, whence they sailed for England, reaching Harwich on the 22nd of November. On the way the elder Philips fell ill of a fever, which detained them for two months at Frankfort. Dr. Roget thereby made acquaintance with the celebrated anatomist Soemmering, whom he called to his aid in attending the patient.

In the spring of 1804 he repaired to Edinburgh with the intention of pursuing his studies, but was called from thence to Bath to attend upon the Marquis of Lansdowne, whom he accompanied to Harrogate, and afterwards to Bowood, as his private physician, remaining with him till the 11th of October.

Being then in his 26th year, and desirous of establishing himself in practice, he took up his residence in Manchester, where, on the death of Dr. Percival, there appeared to be an opening in his profession. He was in the same month appointed one of the physicians to the Infirmary, an institution comprising a large Hospital and Dispensary, a Fever House, and a Lunatic Asylum. Dr. Roget is regarded as having, in conjunction with his colleagues, Mr. Gibson and Mr. Hutchinson, laid the foundation of the Medical School in Manchester. In the winter of 1805–6 he gave with them, a joint course of lectures to the pupils of the hospital on Anatomy and Physiology, himself taking the latter subject and delivering eighteen lectures from 29th January to 31st March, 1806.

In the midst of this apparent devotion to pursuits for which he had shown so much natural taste, and which seemed to promise him success in life, he, strange as it may appear, accepted in November 1806 the appointment of private secretary to Lord Howick, then Secretary of State to the Foreign Department, and afterwards Earl Grey. He very soon, however, became conscious of a dislike for the service, and quitted it in a month, returning to Manchester, where he busied himself again in an occupation in which he was destined to rise to eminence. In the lectures he had already delivered he had introduced, in addition to the subject of Human Physiology, as already taught in the school, a comparative survey of the functions of animals, with a view to its forming a useful branch of general knowledge. Encouraged by this first attempt, he commenced, in January 1807, a more popular course on the Physiology of the Animal Kingdom, at the rooms of the Philosophical and Literary Society. This Society numbered among its then members men of high distinction in science and general attainments. In its proceedings Dr. Roget took an active part, and he was one of its Vice-presidents. His lectures, fifteen in number, were delivered in the evenings twice a week, and were well attended and highly esteemed.

Dr. Roget resigned his post at the Infirmary in October 1808, and transferred the scene of his labours to London, where he established himself in the following January in a house in Bernard Street, Russell Square, and on the 3rd of March was admitted Licentiate of the Royal College of Physicians. He lost no time in commencing on a wider field, the career which had been indicated to him by his success in Lancashire. An opportunity soon offered itself. The Russell Literary and Scientific Institution had been opened in the preceding year under the management of a number of distinguished residents in the neighbourhood, including his uncle, then Sir Samuel Romilly, Mr. James Scarlett (afterwards Lord Abinger), Mr. Francis Horner, &c.; and Dr. Roget and Mr. Pond (the Astronomer Royal) were chosen to inaugurate the first lecture season, in the spring of 1809, by the delivery of two courses of twelve afternoon lectures, the one on Animal Physiology, the other on Astronomy. Dr. Roget's course, repeated in the following year, proved to be the first of a long series on his favourite subject, which established for him a high reputation, in a career of more than thirty years' duration as a public lecturer. It will be convenient here to give a list of these courses.

Besides his lectures at Manchester in 1806 and 1807, and at the Russell Institution in 1809 and 1810, he lectured on the same subject at the Royal Institution in the spring of 1812, 1813, 1814, 1822, and 1823; at the London Institution in the spring of 1824; at the two last-named places concurrently in the spring of 1825; in 1826, at the London Institution in the spring, and at the new Medical School in Aldersgate Street in the autumn; and finally at the Royal Institution in the spring of 1835, 1836, and 1837, as the first Fullerian Professor, to which chair he was nomi-

nated by the founder, Mr. John Fuller. In these courses, which numbered from ten to eighteen lectures each, his favourite arrangement of the subject was that which he had adopted in 1807. After a general survey of Cuvier's classification, he would treat, first, of the mechanical functions; secondly, the chemical functions, circulation, respiration, and nutrition; and thirdly those of the nervous system, and the intellectual faculties. At Aldersgate Street he also dealt with the function of reproduction and evolution. Sometimes, however, he divided his subject zoologically, and dealt separately with each class of animals. In his earlier lectures he made Human Physiology the basis of his comparison, which plan he appears to have gradually exchanged for that in which the interest rises as the scheme of nature is reviewed in successive stages from the lower to the higher orders of the animal kingdom. At the Royal Institution in 1825 and 1836, and at the London Institution in 1826, he confined himself to one department, namely, that of the External Senses. The introductory lecture at the Aldersgate School was published by Longman and Co. in 1826, and of many of his lectures he furnished the abstracts published in the Literary Gazette. In all these discourses Dr. Roget kept in view what he had announced at Manchester as his leading object, namely, "to point out, on the plan pursued by Dr. Paley, those proofs of infinite wisdom and benevolence which are displayed in every part of the universe, but which are nowhere so eminently conspicuous as in the structure and economy of the animal creation."

In October 1809 he projected the foundation of the Northern Dispensary, which, with the cooperation of many influential neighbours, was opened in the following June, with Dr. Roget as its physician. The active duties of this office he performed gratuitously for the next eighteen years. In 1825 he was presented with a handsome piece of plate by the patron and governors. In 1810 he began to lecture on the Theory and Practice of Physic at the Theatre of Anatomy, Great Windmill Street, in conjunction with Dr. John Cooke, who two years afterwards resigned him his share of the undertaking. Dr. Roget then delivered two courses a year until 1815. Among his colleagues there, were Sir Benjamin Brodie, Sir Charles Bell, Mr. Brande, and other leading men of science.

In 1811 he was chosen one of the secretaries of the Medical and Chirurgical Society of London, of which he had been one of the earliest promotors in conjunction with his friends Drs. Marcet and Yelloly. In the same year he published a paper in the Medico-Chirurgical Transactions, vol. ii. p. 136, on "A Case of Recovery from the effects of Arsenic, with remarks on a new mode of detecting the presence of this Metal," to which he afterwards added a note in vol. iii. p. 342. In 1812 he wrote an article in the Edinburgh Review, vol. xx. p. 416, on P. Huber's 'Recherches sur les Mœurs des Fourmis Indigènes.' He was also the writer of the Review in vol. xxv. p. 363, of the same author's 'Nouvelles Observations sur les Abeilles.'

While engaged in these avocations, as well as in professional practice, which about the year 1813 began to be considerable, Dr. Roget was not unmindful of his early passion for the exact sciences. Of Mathematics and Natural Philosophy he made a practical study; and in the year 1814 he contrived a sliding-rule so graduated as to be a measure of the powers of numbers, in the same manner as the scale of Gunter, then in common use, was a measure of their ratios. It is a *logo-logarithmic* rule, the slide of which is the common logarithmic scale, while the fixed line is graduated upon the logarithms of logarithms. The consequence is that powers are read as easily as products are on the common rule, and the arrangement is such that high powers of quantities little exceeding unity, so much wanted in compound interest, statistics, &c., are read off on a single setting. His paper thereon, which also describes other ingenious forms of the instrument, was communicated by Dr. Wollaston to the Royal Society, and read on the 17th of November, 1814. It appears in the Philosophical Transactions for 1815, p. 9. It was through this communication that he gained admission to the Society. He was elected Fellow on the 16th of March, and admitted on the 6th of April, 1815. The date of this epoch in his life is noteworthy in relation to the importance which he attached to his deliverance in 1803 from the clutches of Bonaparte. The year in which his paper was read was that of his young friend Edgeworth's release. The manner in which the interval had been employed affords a measure of the loss which he and others would have incurred had he been destined to the like exile.

The next decade in Dr. Roget's life was a period of active industry, passed in the society of many of the most distinguished men of his time. Besides his occupations above specified, he employed his pen in the production of various published writings. In 1815 he contributed a paper to the Medico-Chirurgical Transactions, vol. vii. p. 290, "On a Change in the Colour of the Skin produced by the internal use of Nitrate of Silver." At various periods between 1815 and 1822 he wrote the following treatises and articles in the Supplement to the sixth edition of the 'Encyclopædia Britannica;' viz. Ant, Apiary, Barthez, Beddoes, Bee, Bichat, Brocklesby, Broussonet, Camper, Cranioscopy, Currie, Deaf and Dumb, Kaleidoscope, and Physiology. In 1818 he wrote a letter "On the Kaleidoscope" to the Editors of the 'Annals of Philosophy,' which was published in vol. xi. p. 375. That year was saddened by the melancholy death of his uncle, Sir Samuel Romilly. In July 1820 he was appointed Physician to the Spanish Embassy, which office he retained for many years. In the same year he wrote a letter to Mr. Travers on a voluntary action of the Iris, which was published by Mr. Travers in his work 'On the Diseases of the Eye;' and an Appendix to Larkin's 'Introduction to Solid Geometry and to the Study of Crystallography,' in which Dr. Roget demonstrates the ratios subsisting between the volumes of solids composing the artificial series, together with the various inclinations of their faces. In 1821 he wrote "Observations on

Mr. Perkins's Account of the Compressibility of Water," in the 'Annals of Philosophy,' N. S. vol. i. p. 135 ; and in 1822, a Biographical Memoir of his valued friend and frequent fellow-worker Dr. Alexander Marcet, in the 'Annals of Biography and Obituary' for 1823. In 1823 he is quoted by Dr. Cooke in his work on Epilepsy, pp. 147, 151, & 215. On the 1st of May in the same year he was appointed Physician to the General Penitentiary, Milbank, in conjunction with Dr. P. M. Latham, on the occasion of an epidemic dysentery which prevailed among the prisoners. His labours there occupied him for fifteen months ; and in 1824 appeared the joint report of himself and his colleague to the House of Commons. In the autumn of that year was another great epoch of his life, namely that of his marriage.

Dr. Roget married Miss Hobson, only daughter of Mr. Jonathan Hobson, a merchant of Liverpool. The union was one of unclouded happiness, but of short duration. Mrs. Roget, after giving birth to a daughter and a son, died in the spring of 1833, of a lingering disease.

On the 9th of December, 1824, another mathematical paper of Dr. Roget's was read at the Royal Society; this is entitled "An Explanation of an Optical Deception in the appearance of the Spokes of a Wheel seen through vertical apertures" (Phil. Trans. for 1825, p. 131); and in 1825 he wrote another in the 'Scientific Gazette,' Nov. 5 and 12, "On an apparent violation of the Law of Continuity." In 1826, besides his "Introductory Lecture," there appeared an article by him on Electro-Magnetism in the 'Quarterly Review,' being a review of Ampère's 'Recueil d'Observations Electro-Dynamiques,' and Barlow's 'Essay on Magnetic Attractions;' and an article "On the Quarantine Laws," in the Parliamentary Review, p. 785.

In 1827 he received a commission, with Mr. Telford and Mr. Brande, under the Great Seal, to inquire into the supply of water to the Metropolis, which resulted in the publication of their report in 1828.

He began at this time the composition of the series of treatises in the 'Library of Useful Knowledge' on "Electricity, Galvanism, Magnetism and Electro-Magnetism." They were issued in parts in the years 1827 1829, and 1831, and were afterwards published together in one volume. These treatises were held in considerable repute at the time they were published, and that on Electricity reached a second edition. He also wrote the article GALVANISM in the 'Encyclopædia Metropolitana.' His connexion with the Society for the Diffusion of Useful Knowledge, for which the above treatises were written, is thus referred to by Mr. Charles Knight, in his 'Passages of a Working Life':—"Amongst the founders of this Society, Dr. Roget was, from his accepted high reputation, the most eminent of its men of science. He was a vigilant attendant on its committees ; a vigilant corrector of its proofs. Of most winning manners, he was as beloved as he was respected. . . . . Upon all questions of Physiology, Peter

Mark Roget and Charles Bell are the great authorities in the Useful Knowledge Society."

On the 30th of November, 1827, Dr. Roget was elected Secretary of the Royal Society, on the retirement of Mr. (afterwards Sir John) Herschel.

In company with his friend Dr. Bostock in 1828, and again with Mrs. Roget in 1830, shortly after the "three days" revolution of that year, he revisited Paris, with what recollections it is easy to imagine. In the former year a distinguished friend of Dr. Roget's died, for whom he had a peculiar veneration, namely Dr. Wollaston, and in 1829 he lost his early adviser, Dumont. In 1829 and 1830 he occupied the chair as President of the Medical and Chirurgical Society, of which he had ceased to be secretary three years before. In 1828 he wrote an article in the 'Parliamentary Review' on "Pauper Lunatics;" and in 1831 he contributed to the 'Journal of the Royal Institution of Great Britain,' vol. i. p. 311, a paper "On the Geometric Properties of the Magnetic Curve, with an account of an Instrument for its mechanical description." In June in the same year he was elected, *speciali gratia*, Fellow of the Royal College of Physicians, and in the following May he read the 'Gulstonian Lectures,' for which he selected as his subject "The Laws of Sensation and Perception." An abstract of them, written by him, appeared in the 'London Medical Gazette' for that month. In 1832 he furnished the articles AGE and ASPHYXIA to the 'Cyclopædia of Practical Medicine,' published under the superintendence of his friend Dr. Tweedie. Before this time, but at what precise date has not been ascertained, he had written the following articles in 'Rees's Cyclopædia; viz. SWEATING SICKNESS, SYMPTOM, SYNOCHA, SYNOCHUS, TABES, and TETANUS.

The year 1833 was one of great trial. The absorbing grief which he suffered on the death of his wife made other sorrows seem light; but several family afflictions occurred at the same time. Dr. Roget sought to divert his mind in the society of his scientific friends, and in the interest he could still take in scientific pursuits. He attended the Meeting at Cambridge of the British Association, which had been founded two years before at York. These gatherings were always a source of great delight and interest to him, and he was a frequent attendant at them for the next thirty years. At one or more of the earlier Meetings he filled the chair of the Physiological Section.

Fortunately also he was at this time engaged in an undertaking with which his memory will ever be associated, namely, the production of one of the 'Bridgewater Treatises.' The most important department of that celebrated series, executed under the will of the Earl of Bridgewater, to illustrate "the Power, Wisdom, and Goodness of God, as manifested in the Creation," had been assigned to Dr. Roget by the late President of the Royal Society, Mr. Davies Gilbert, to whom the selection was *ex officio* intrusted. His treatise, which forms the fifth of the series and is in two

volumes, has for its title "Animal and Vegetable Physiology considered with reference to Natural Theology." As the testator had specified "the effect of digestion, and thereby of conversion," and "the construction of the hand of man," as instances of the "reasonable arguments" whereby the collective work was to be illustrated, were departments assigned to other writers, to be dealt with in separate treatises; but with these exceptions, Dr. Roget's province was to embrace nearly the whole of the physiology of the two kingdoms of nature. Of the manner in which he performed the task it is needless to speak at length here. As the prescribed purpose of the work was the very object which he had set before him and retained in view ever since his early efforts at Manchester, he naturally adopted the arrangement which he had found best in his lectures, and he endeavoured to embody in the form of a compendium so much of the argument and such of the illustrations as were adapted to every class of readers, and might form a useful introduction to the study of Natural History. Since the time of Roget the science of Comparative Anatomy has entered upon new phases, then but dimly foreshadowed; but still his Bridgewater Treatise may be read with profit and delight by all, on account of the deeply interesting nature of the subject, the lucidity of the argument, the variety of illustration, the pure religious tone which pervades it, and the admirable style in which it is composed. Of the work in its original form three editions were published—the first and second in 1834, and the third in 1840; and two years before his death, the author superintended the passing through the press of a fourth edition, published by Messrs. Bell and Daldy. Dr. Roget was the last survivor of the authors of the Bridgewater Treatises.

In the years 1834 and 1835 he held the office of Censor to the Royal College of Physicians. In 1837 and subsequent years he took an active part in the establishment of the University of London, of the Senate of which he remained a member until his death; and in June 1839 he was appointed Examiner in Physiology and Comparative Anatomy, which office he held for some years. In 1838 his pen was again employed by the editors of the 'Encyclopædia Britannica,' to the seventh edition of which he contributed the articles Banks (Sir Joseph), Phrenology, and Physiology. The last two were published separately in two volumes. That on Phrenology was, with some additions, a reprint of the article "Cranioscopy" belonging to the former edition. In the original article he had expressed his strong dissent from the conclusions of the phrenologists, and this had given rise to answers on their part, particularly by Mr. George Combe, in "Essays on Phrenology," Edinb. 1819, and by Dr. Andrew Combe in the 'Phrenological Journal.' To these criticisms, which were at least a tribute to the ability with which he had argued his case, Dr. Roget took this opportunity to reply. The article "Physiology" was an entirely new and comprehensive treatise, describing the various functions of the animal economy. That which he had before written under the same title was confined to the philosophical department of the subject, containing an analytical investigation

of the several classes of vital powers and their mutual relations, and pointing out the necessity of distinguishing, more carefully than had been done by early inquirers, between physical and final causes. In 1844 Dr. Roget again travelled abroad, revisited Geneva, and took the opportunity of attending the Meeting of the Italian Scientific Association held that year at Milan.

In other respects his public life during his long term of office as Secretary was intimately associated with the annals of the Royal Society. In the course of that time changes had been introduced which rendered the duties of the Senior Secretary exceedingly laborious. Not only did the task of editing the Proceedings both of the Society and of the Council fall to his share, but also that of making and preparing for publication the Abstracts of Papers read. This labour was performed by Dr. Roget from November 1827 until his retirement from office in 1848. Ever devoted to the interests of the Society and to his own important duties, he at times found his position one of great delicacy, and his name had occasionally to appear in the front rank of polemical warfare. On these occasions he maintained his position by firmness and forbearance, while sometimes smarting under undeserved attacks. On the 7th of November, 1836, a vote of thanks was accorded to him by the Society.

On retiring from office, although in his seventieth year, he at once embarked in a laborious undertaking which he had projected many years before. As long ago as the year 1805 he had formed, for his own use in literary composition, a small classed catalogue of words, which vocabulary had often proved of great service to him in his writings. This he determined to expand into a work of general utility, and after three or four years of labour he published, as its result, the now well-known 'Thesaurus of English Words and Phrases, classified and arranged so as to facilitate the expression of ideas, and assist in Literary Composition.' The appreciation which the work has received may be inferred from the fact that it has reached a twenty-eighth edition. It first appeared in 1852, and after running through two editions, was reduced to a more portable form, and stereotyped. Not the least remarkable part of the work is the arrangement, at once philosophical and practical, of the Ideas, which forms the basis of the classification. The book may be shortly described as the converse of an ordinary dictionary. A dictionary sets forth the idea belonging to a given expression; the 'Thesaurus' supplies the expression to a given idea. A French 'Thesaurus,' in which the author, Mr. T. Robertson, adopted in all its details Dr. Roget's arrangement, was published in Paris in 1859, with the title "Dictionnaire Idéologique. Recueil des Mots, des Phrases, des Idiotismes, et des Proverbes de la Langue Française classés selon l'ordre des Idées." An imitation of the original work, but omitting all the phrases from the classification, was also produced in America.

With the publication of the 'Thesaurus,' Dr. Roget's public career may be said to have closed. He had for many years retired from practice, and

now an increasing deafness excluded him to a great extent from the pleasures of social intercourse. This infirmity, which was almost the only sign of his great age, he bore with patience and resignation. He had survived all the friends of his youth and most of those of his manhood; but he was happy in the possession of mental resources, which enabled him to indulge, even to his last day, the habits of constant industry which he had acquired when a boy. As with advancing age he became less inclined for, and at last less capable of, deep study or long-sustained thought, his employments partook more of the nature of pastimes; but both in his selection and pursuit of these there might still be traced the scientific turn of thought and philosophical love of method which had characterized the main achievements of his life. The engines he had forged to store his mind were now employed to entertain his leisure. One example of this was very remarkable. At an early period (May 1811) he had attended a course of lectures by the celebrated Feinaigle, of whose system of Mnemonics he made constant use throughout life. This system comprises two main devices for a *memoria technica*. The one is designed to record chronological facts, or indeed any facts connected with the ordinary succession of numbers, the other to impress separate figures upon the memory. The first object is accomplished by a methodical arrangement in well-known portions of space, such as the sides of a room; the second by means of words which can be easily remembered, and of which the letters are made to represent figures under a conventional rule of interpretation. Of both these sources Dr. Roget had availed himself largely. He had applied the former to a great variety of subjects. For him familiar places had thus an additional interest. The houses he had lived in, and those of friends whom he had visited, the old rooms of the Royal Society at Somerset House, and of various Institutions which he frequented, were pictured to his mind's eye as peopled with an infinitude of facts, and teeming with varied information. The chronicle of universal history, the measurement of earth and sky, the epochs of his life and of those of his contemporaries, the sources of his income, the categories of his 'Thesaurus,' the general arrangement of human knowledge, were all recorded in this manner on the tablets of his memory. Of the second device, he had also made extensive application. Logarithms, approximations to surds, and various ratios in common use in computation were set by him to doggrel phrases, which it was an amusement to repeat to himself as he walked; and he would sometimes astonish his acquaintance by accurately stating the value of π to forty or fifty places of decimals.

He was always fond of mechanical contrivances, and at one period spent much time and labour in attempts to construct a calculating machine. This design he abandoned on seeing the beautiful engine of Professor Scheutz, of which he at once admitted the superiority. He also made some progress towards the invention of a delicate balance, in which, to lessen the effect of friction, the fulcrum was to be within a small barrel floating on water.

Scientific toys were a source of great delight to him, as has been already seen in his study of the kaleidoscope. Late in life he amused himself much with conversions of plane rectilinear figures of equal areas—cutting out pieces of card so that they could be differently put together to prove the equality, and thereby forming a series of geometrical recreations. He was also fond of exercising his ingenuity in the construction as well as the solution of chess problems, of which he formed a large collection. Some of those figured in the 'Illustrated London News' were of his invention. To assist persons interested in the same pursuit, he contrived and published (in 1845) a pocket chess-board, in which small men of card, lying flat on the board, were kept in place by the insertion of their bases into folds or pockets in the chequered paper which composed it. In the 'London and Edinburgh Philosophical Magazine' for April 1840, there is a "Description of a Method," which he invented, "of moving the Knight over every square of the chess-board without going twice over any one; commencing at a given square and ending at any other given square of a different colour." The complete solution of this problem, which had engaged the attention of some of the most eminent mathematicians, including Euler and De Moivre, had never been effected before.

During his latest years, which were passed in complete retirement, he derived great amusement from light epigrammatic literature, still collecting and classifying according to his wont; but his chief resource was in the pages of his 'Thesaurus,' to which he continued to make additions until the last day of his life. His constant spirit of cheerfulness as his end drew nigh, and the kindness and benevolence which endeared him to all around, befitted a life spent in accordance with his belief that the purpose of our existence here on earth is that of doing good to our fellow creatures in furtherance of God's everlasting glory. After spending last summer at Malvern in the enjoyment of his usual health, his strength failed him during the great heat of August, and on the 12th of September he expired, peacefully and without suffering, from the natural decay of that vital power the mysterious working of which he had so laboured to illustrate.

Dr. Roget was also Consulting Physician to Queen Charlotte's Lying-in Hospital; Hon. Member of the College of Physicians in Ireland; Fellow of the Astronomical, Entomological, Geographical, Geological, and Zoological Societies, and the Society of Arts; Member of the Royal Institution; Hon. Member of the Institute of Civil Engineers, of the College of Physicians in Ireland, and of the Literary and Philosophical Societies of Liverpool, Bristol, Quebec, New York, Haarlem, Turin, Stockholm, and Athens. He was also a member of a variety of social scientific clubs, among others, an Honorary Member of the Smeatonian Society of Civil Engineers; and he was at the time of his death the "father" of the Royal Society Club, of which he had been a member since 1827.